PROC. ENTOMOL. SOC. WASH.
89(4), 1987, pp. 665–672

HOST SPECIFICITY AND LABORATORY REARING STUDIES OF *MEGACYLLENE MELLYI* (COLEOPTERA: CERAMBYCIDAE), A POTENTIAL BIOLOGICAL CONTROL AGENT OF *BACCHARIS NEGLECTA* BRITT. (ASTERACEAE)[1]

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Abstract.—The stem borer *Megacyllene mellyi* (Chevrolat), originally from Brazil and imported from Australia, was studied in quarantine as a possible biological control agent of *Baccharis halimifolia* L. and *B. neglecta* Britt. (Asteraceae) in the United States. Larvae were reared for 30–45 days on stems of *Baccharis* before being transferred to artificial diet containing milled *Baccharis* stems. Developmental times for colony-reared insects at 26°C were: eggs, 10.7 days; larvae, 99.2 days; pupae, 15.2 days; and adults, 10–29 days. There were 3 generations/year. Host specificity tests were conducted on 35 species of plants. Oviposition occurred on *Baccharis*, a few weedy Astereae shrubs and large, rough-barked stems of some trees of other plant families. Larvae, however, successfully developed only on *Baccharis*. Female borers were attracted to a volatile water-soluble chemical in the phloem layer of stems of *B. neglecta* and preferred to oviposit on large stems with rough bark.

The genus *Baccharis* (Asteraceae: Astereae) consists of 511 species of unisexual shrubs, most of which occur in Brazil, Argentina, or Chile (Malagarriga, 1976; Barroso, 1976). Approximately 21 species occur in southern United States (Anon., 1982), including three undesirable weeds of rangelands, pastures, and low areas: *B. halimifolia* L., *B. neglecta* Britt., and *B. salicifolia* (R&P) Pers. These native species attain heights of 2 to 4 m, are prolific seed producers, tolerate a wide range of soil types and salinity conditions, and regrow from basal stem buds (Scifres, 1980; Westman et al., 1975). Control methods such as shredding and burning are only temporary, whereas herbicide applications are effective but expensive (Mutz et al., 1979). *Baccharis halimifolia* occurs from Texas to Florida and as far north as Massachusetts (Tarver et al., 1979) and is unpalatable and not grazed by livestock (White, 1936). The leaves contain a cardiotoxic glucoside that is poisonous to cattle (Manley et al., 1982) and poultry (Duncan et al., 1957). The pollen causes hay fever in humans (Wodehouse, 1971). Another species, *Baccharis neglecta*, has infested over 330,000 ha of range and pasture land in Texas (unpublished brush survey, 1982, USDA Soil Conservation Service, Temple, Texas) and progressively has become a management problem on productive grassland soils and abandoned fields (Mutz et al., 1979; Scifres, 1980). *Baccharis salicifolia* is an undesirable phreatophyte and is also unpalatable

[1] Mention of a proprietary product does not constitute an endorsement or a recommendation for its use by the U.S. Department of Agriculture.

as forage as well as forming dense thickets along streams (Parker, 1972).

The stem borer, *Megacyllene mellyi* (Chev.) (Coleoptera: Cerambycidae), is native to South America. In Brazil, its preferred host plant is *B. microdonta* DC., but it occasionally attacks *B. dracunculifolia* DC., *B. spicata* (Lam.) Baillon, *B. tridentata* Vahl and *Baccharidastrum* sp. (Bennett, 1963; McFadyen, 1979). Adults are black in color with red markings on the elytra and white setae scattered on the legs, head and thorax. The larvae bore through the bark and feed beneath the surface. Stems which contain several larvae are weakened (McFadyen, 1979).

The host specificity of *M. mellyi* was determined by McFadyen (1983) for use in Australia as a potential biological control agent against *B. halimifolia.* He tested 55 species of economically important plants and 20 species of plants that were hosts or closely related to plants attacked by other *Megacyllene* spp. Females deposited most eggs on *B. halimifolia,* but a few were also deposited on the leaf surfaces of corn, peach, pear, grape, and pineapple; however, larvae did not survive on any of the test plants. The borer was approved for introduction and released in Queensland, Australia in 1978 (McFadyen, 1983).

To be considered for release in the United States, we tested *M. mellyi* for ovipositional preference and larval survival on various plants of economic importance in North America, native asters which are closely related to *Baccharis,* and host plants of the native *Megacyllene.* The results of this testing and the data collected from laboratory-rearing studies are presented in this report.

Materials and Methods

A laboratory colony of *M. mellyi* was maintained from June 1982 to September 1984 under strict quarantine conditions at Temple, Texas. The colony was started and replenished with shipments of larvae and pupae from the Alan Fletcher Research Station, Queensland Department of Lands, Sherwood, Australia. Rearing methods for the colony were similar to those used by A. Tomley and P. McFadyen (pers. comm.) of the Alan Fletcher Research Station. Cut stems (3–6 cm diam. × 40–50 cm length) of either *B. neglecta* or *B. halimifolia* were exposed to ovipositing females for 3–5 days depending on the number and age of the adults in the cage. Ends of the stems were dipped in hot paraffin wax to conserve moisture. Females oviposited under 2 cm wide strips of cotton cloth tightly spiraled around the stems. These cloth strips increased the number of oviposition sites, encouraged females to oviposit over a larger area of the stem and provided a source of eggs attached to cloth for some of the experiments. The *Baccharis* stems were then placed in a polyethylene bag, sprayed with water from 3 to 6 times weekly to maintain high humidity, and held at 26°C for 30 to 50 days. Stems of *B. halimifolia* were preferred for rearing larvae because they did not split and dry as rapidly as did stems of *B. neglecta.* After 30 to 50 days the stems were dissected and each larva was placed in a hole in a 1 cm^3 piece of artificial diet in a glass vial. The diet was replaced ca. once every 2 weeks. For mature larvae the diet was provided in granular form. The diet used was similar to the diet of Harley and Willson (1968) except the cellulose was replaced with an equal weight of milled *Baccharis* stem.

Pupae and teneral adults were held in empty vials for 3–5 days after emergence. Teneral adults used in the experiments were held for an additional 5 days before testing and were given only water and honey solution on cotton pads.

All tests were conducted between October and June 1982 to 1984, in the quarantine greenhouse (Boldt, 1982), with a natural photoperiod and at temperatures of ca. 30°C in the day and 20°C at night. An entire experiment could not be done at the same time but there was one control treatment each

Table 1. Plant species used in the host specificity testing of *M. mellyi*.

Family	Species	Common Name
Gramineae	*Saccharum officinarum* L.	sugarcane
Gramineae	*Sorghum vulgare* Pers.	sorghum
Juglandaceae	*Carya illinoinensis* (Wang) K. Koch	pecan
Juglandaceae	*Juglans nigra* L.	black walnut
Ulmaceae	*Celtis laevigata* Willd.	Texas sugarberry
Ulmaceae	*Ulmus crassifolia* Nutt.	cedar elm
Moraceae	*Ficus carica* L.	fig
Rosaceae	*Prunus persica* (L.) Batsch.	peach
Leguminosae	*Albizia julibrissin* Durazz.	mimosa-tree
Leguminosae	*Gleditsia triacanthos* L.	honey locust
Leguminosae	*Phaseolus vulgaris* L.	bean
Leguminosae	*Prosopis glandulosa* Torr.	honey mesquite
Leguminosae	*Sophora affinis* T. & G.	Eve's necklace
Balsaminaceae	*Impatiens balsamina* (L.) Lam.	impatiens
Vitaceae	*Vitis vinifera* L.	Niagara grape
Malvaceae	*Gossypium hirsutum* L.	cotton
Convolvulaceae	*Ipomoea batatas* (L.) Lam.	sweet-potato
Cucurbitaceae	*Cucurbita pepo* L.	pumpkin
Asteraceae[a]		
Astereae	*Baccharis halimifolia* L.	
Astereae	*Baccharis neglecta* Britt.	
Astereae	*B. pilularis* DC.	coyote bush
Astereae	*B. brachyphylla* Gray	
Astereae	*Gutierrezia microcephala* DC.	threadleaf snakeweed
Astereae	*Isocoma drummondii* (T. & G.)	Drummond's goldenweed
Astereae	*Ericamerica austrotexana* M.C. Johnst.	false broomweed
Astereae	*Aster novae-angliae* L.	New England aster
Astereae	*Aster* sp.	Michaelmas daisy
Astereae	*Erigeron aurantiacus* Regel.	midsummer aster
Astereae	*Chrysothamnus nauseosus* (Pall.) Britt.	rubber rabbitbrush
Astereae	*Solidago altissima* L.	tall goldenrod
Astereae	*Conyza canadensis* (L.) Cronq.	horsetail conyza
Heliantheae	*Chrysanthemum morifolium* Ramat.	florists mum
Heliantheae	*Helianthus annuus* L.	sunflower
Inuleae	*Antennaria fallax* Greene	large leaf pussy's toes
Anthemideae	*Artemisia filifolia* Torr.	sand sagebrush
Eupatorieae	*Eupatorium compositifolium* Walt.	yankee weed

[a] Tribes.

time any plants were tested. The control plant, *B. halimifolia*, was replaced by *B. neglecta* in the multiple choice oviposition and attractants tests because it was locally common and fresh stems were readily available. Plants tested are listed in Table 1. During the oviposition tests, cage interiors were sprayed twice daily with water. Means and standard deviations were calculated for the data.

No-choice oviposition test.—In this test, ten unsexed adults were confined in a screen cage (20 cm diam. × 50–90 cm ht.) for 10 days on each individually potted plant. At the end of the test, the plant was dissected to record the number of eggs.

Multiple-choice oviposition tests.—In the first test, 40 unsexed adults were confined for 10 days in a 1 m^3 screen cage with 4 woody stems of each of 3 species of shrubs or trees listed in Table 2 and 4 stems of *B. neglecta*. All stems (ca. 3.5 cm diam. × 40

cm length) were cut in the field 4 to 24 hours before the start of the test. A hole (7.6 cm deep × 0.32 cm diam.) drilled in one end of each stem enabled the stem to stand upright over a nail driven up through the wood floor. Cut ends of each stem were coated with a thin layer of paraffin wax to reduce moisture loss. Stems were arranged in the cage in a Latin-square design. Ten species of plants plus *B. neglecta* were tested in this experiment. At the end of each test the stems were dissected and the number of eggs present and their location on the stem were recorded.

In the second test, 15 unsexed adults were also confined in each cage for 10 days with only one stem of each of 3 plants plus 1 stem of *B. neglecta*. One replicate consisted of 3 cages of 3 plant stems each and 1 *B. neglecta* stem in each cage. The experiment was replicated 4 times using all combinations of test plants.

Larval survival test.—A strip of cotton cloth from the rearing colony, containing 10 (0–24-h old) attached eggs, was taped to each stem used in the experiment. The stems were cut in the field, 4–24 h before the test and soaked in water for ca. 3 h; the cut ends were dipped in hot paraffin wax to maintain moisture content. Eggs and stems were then held in moist peat moss in a polyethylene plastic cage (2 × 1 × 1 m^3) at 27 ± 1°C, and 75–85% RH. After 5 to 7 weeks, the stems were dissected and the number of hatched eggs, tunnels and surviving larvae were determined. Larvae were considered to have fed in the bark if a small pile of sawdust or the entrance of a tunnel was found near an egg. Either 3 or 4 replications of 10 eggs per stem were made for each of the 10 plants in the experiment.

Chemical attractancy test.—After bark was removed from freshly cut stems of *B. neglecta*, 0.08 mm thick chips of wood were carefully shaved from the phloem area with a hand plane. Fifty gm fresh weight of the phloem chips were homogenized in a blender with 500 ml of deionized water and allowed to steep at room temperature for ca. 12 h. This liquid was then vacuum filtered through Whatman® 4 filter paper and centrifuged at ca. 15°C at 3200 ×g for 30 min. The supernatant was poured into 50 ml plastic bottles and stored at −20°C until used.

Four dead stems of mesquite, *Prosopis glandulosa* Torr. (4–5 cm diam. × 50 cm length), with ends sealed in hot paraffin and spiral wrapped with a 2-cm wide band of white cotton cloth were placed upright in a screen cage (50 × 50 × 70 cm). Mesquite was selected because the ridges and deep grooves of the bark were similar to those of *Baccharis* and because it is not closely related to it. Two of the cloth strips had been previously soaked in 50 ml of phloem supernatant and two had been soaked in deionized water for 12–16 h. Twenty unsexed adults were placed in the cage; after 3 days the logs were dissected and the number of eggs recorded. Six replications were made.

Physical attractancy test.—Two each of three sizes of stems of freshly cut *B. neglecta*—small (1.0–1.2 cm diam.), medium (2.6–3.0 cm diam.), and large (4.3–5.4 cm diam.)—were placed upright in a screen cage and exposed to 20 unsexed adults for 3 days. All areas of the stem without bark were carefully sealed with paraffin. After exposure, the logs were dissected and the number of eggs recorded. Two replications were made.

Results

Laboratory rearing.—Adults of *M. mellyi* were 11.2 ± 0.5 mm (n = 26) long and lived 20 to 35 days in the laboratory. Feeding occurred on the pollen of several species of Asteraceae and a 10% honey solution in a saturated cotton pad. No diapause was apparent and 3 generations/year were reared in the laboratory. Females oviposited in narrow cracks or under pieces of bark on the rough surfaces of woody stems of *Baccharis*.

The eggs (length = 1.41 ± 0.08 mm, width = 0.56 ± 0.005 mm, n = 50) were opaque white and tapered on both ends. In-

Table 2. Number of eggs laid by *M. mellyi* in no-choice test.

Plant		Eggs	
Species	No. Plants[a]	No. laid	No./Plant[b]
Baccharis halimifolia	7	226	32.3 ± 22.7
Coyote bush	1	35	35.0
B. brachyphylla	1	4	4.0
Threadleaf snakeweed	3	1	0.3 ± 0.58
Drummond's goldenweed	3	1	0.3 ± 0.58
False broomweed	3	6	2.0 ± 3.46
New England aster	3	0	–
Michaelmas daisy	3	0	–
Florists mum	2	0	–
Sunflower	2	0	–
Midsummer aster	1	0	–
Impatiens	1	0	–
Rabbitbrush	1	1	1.0
Yankee weed	3	3 (on leaves)	1.0 ± 1.0
Large leaf pussy's toes	2	0	–
Sand sagebrush	2	0	–
Tall goldenrod	1	0	–
Horsetail conyza	1	0	–
Sugarcane	4	2 (on leaf)	0.50 ± 0.58
Sorghum	1	0	–
Cotton	2	0	–
Snapbean	1	0	–
Pumpkin	2	0	–
Grape	2	0	–
Sweet potato	2	0	–

[a] Ten adults/plant.
[b] Mean ± standard deviation.

cubation period at 26°C was 10.7 ± 0.65 days (n = 99). Percent hatch for 456 eggs was 92.1%. Young larvae fed in the wood just below the bark for 30 to 45 days before being transferred to diet. Mean duration of the larval stage was 99.2 ± 21.6 (n = 44) and mean duration for the pupal stage was 15.2 ± 6.2 (n = 43) days.

No-choice oviposition test.—Twenty-five species of plants, representing nine families, were included in the single plant no-choice oviposition test (Table 2). Of the total of 279 eggs laid, 81.0% were placed on *B. neglecta* and 12.5% on *B. pilularis* DC.; the remainder were distributed between six species of shrubby Astereae and one commercial plant, sugarcane, *Saccarum officinarum* L. Eggs were usually laid singly in crevices and narrow depressions or under loose pieces of bark except on sugarcane and yankee weed, *Eupatorium compositifolium* Walt., where they were laid on the smooth upper surface of the leaves. Several eggs were also found on the screen of a cage containing a threadleaf snakeweed plant, *Gutierrezia microcephala* DC.

Multiple-choice oviposition test.—Eleven species of shrubs and trees, representing 8 families, were included in the multiple-choice ovipositional test (Table 3). Oviposition in both tests was greatest on stems of *B. neglecta* although eggs were also laid on 5 other plants in the first and 8 other plants in the second test. Of the total of 1400 eggs laid in the two tests, 87.4% were laid on *B. neglecta* and 4.2% were laid on honey mes-

Table 3. Number of eggs laid by *M. mellyi* on woody stems in multiple-choice tests.

Plant	Test 1			Test 2		
	No. of Stems	Eggs		No. of Stems	Eggs	
		No. Laid	No./Stem[a]		No. Laid	No./Stem[a]
Baccharis neglecta	16	765	47.8 ± 33.8	12	459	38.3 ± 22.6
Honey mesquite	8	34	4.3 ± 12.0	4	25	6.3 ± 11.8
Eve's necklace	8	10	1.3 ± 1.0	4	9	2.3 ± 4.5
Texas sugarberry	4	5	1.3 ± 2.5	2	3	1.5 ± 2.1
Walnut	8	4	0.5 ± 1.1	4	1	0.25 ± 0.5
Pear	4	4	1.0 ± 2.0	4	2	0.5 ± 1.0
Pecan	4	0	—	4	57	14.3 ± 10.4
Honey locust	4	0	—	4	9	2.3 ± 2.6
Fig	4	0	—	4	5	1.3 ± 2.5
Mimosa-tree	4	0	—	4	0	—
Cedar elm	—		—	2	8	4.0 ± 2.8

[a] Mean ± standard deviation.

quite. No eggs were laid on pecan, *Carya illinoinensis* (Wang) K. Koch, in the first test but 20.9% of the total were on pecan in the second test. The only plant with no eggs in either experiment was mimosa-tree, *Albizia julibrissin* Durazz.

Larval survival test.—Twelve species of trees and shrubs representing 9 families were included in the larval survival test (Table 4). Eclosion ranged from 70 to 90% on each plant species. Feeding damage by newly hatched larvae was observed in the bark of all plants and was recognizable by the presence of a small pile of sawdust around a small entrance hole in the bark. Of the 38 larvae which survived the average 43-day duration of the tests (ca. one-half of the normal larval developmental period of 99 days), 37 had tunneled into the *Baccharis* spp. and 1 larva had tunneled into a fig, *Ficus persica* L. The tunnel of the latter larva was small and located between the bark and wood; it was also smaller than any larval tunnel in *Baccharis*. The fig stem appeared to have a high moisture content which may have aided survival of the larva by preventing desiccation. The damage in the remainder of the plants was limited to one short tunnel per larva in the bark which did not extend to the wood.

Attractancy tests.—In the test for chemical attractancy, adults were exposed to cloth strips that had previously been soaked in water extract from the phloem layer of a stem of *B. neglecta*; control strips were soaked in deionized water. Females laid a mean of 59.6 ± 43.5 eggs per replicate on stems with the *Baccharis* extract and 1.0 ± 1.5 eggs on the control.

In the test for physical attractancy, adults were given a choice of 3 types of stems of *B. neglecta* for oviposition. Females laid 1.0 ± 1.4, 4.0 ± 2.8, and 40.0 ± 25.4 eggs/replicate on small, medium, and large stems, respectively. The largest stems had bark with the most ridges and deepest grooves.

Discussion

The oviposition tests indicate that *Baccharis* is the preferred host plant (Tables 2 and 3). Oviposition occurred only on *Baccharis* and some rough-stemmed woody perennials and did not occur on commercial asters or on non-woody plants outside of the tribe Astereae.

A few eggs were also loosely laid on the leaf surface of yankee weed, sugarcane, and the screen of the cage. However, this was probably the result of the artificial conditions of the test. Eggs laid on leaves in the field would have little chance of survival due to normal predation.

Table 4. Summary of survival of larvae of *M. mellyi* for 5 to 7 weeks in stems of various woody plants, 1983–84.

Plant	Eggs		Larvae	
	Total	No. Hatched (%)	No. Fed in Bark (%)	No. Survived (%)
Baccharis halimifolia	66	65 (98)	44 (67.7)	28 (43.1)
B. neglecta	70	63 (90)	32 (50.8)	9 (14.3)
Fig	40	28 (70)	7 (25.0)	1 (3.6)
Pecan	40	36 (90)	20 (55.5)	0
Mimosa-tree	40	33 (82)	20 (60.6)	0
Walnut	40	40 (100)	14	0
Cedar elm	30	30 (100)	21 (70)	0
Sugarberry	30	23 (77)	1	0
Honey mesquite	30	30 (100)	6	0
Honey locust	30	29 (97)	5	0
Eve's necklace	30	30 (100)	11	0
Pear	10	9 (90)	4	0

Females are attracted to their host plant or are stimulated to oviposit by both chemical and physical means. The presence of water-soluble chemicals which attracted *M. mellyi* or stimulated oviposition was demonstrated to exist in the phloem layers of *B. neglecta* and probably exists in *B. halimifolia* as well, although this plant was not tested. Females searching the surface of the stem preferred to oviposit on large stems with rough bark and deep grooves. These grooves were simulated in the rearing cage by wrapping a strip of cloth around a stem to increase the number of oviposition sites.

Results of the larval survival test (Table 4) as well as those of McFadyen (1983) indicate that *M. mellyi* is restricted to plants in the genus *Baccharis* and after additional testing on the commercial shrub *B. pilularis* should be considered as a potential biological control agent for the United States. Although neonate larvae fed to varying degrees in the bark of most of the test plants, they neither penetrated the phloem layer nor fed into the woody portion of the stem. Bark is apparently a neutral material which does not contain stimulatory chemicals and is tolerated by the larvae only in an effort to reach the wood. Larvae survived for 5–7 weeks only on *B. halimifolia, B. neglecta,* and fig. The single larva on fig, however, was small and in poor condition at the time the stem was dissected. It probably could not have survived much longer.

Larvae of *M. mellyi* can cause severe damage to *Baccharis,* but the borer's effectiveness as a biological control agent is difficult to evaluate. In Brazil, stems that contain several larvae are weakened and plants less than one meter in height may be killed (McFadyen, 1979). In Australia, releases made on *B. halimifolia* in 1978 are established but populations are slow to increase and damage is inconsistent (McFadyen, 1983).

Acknowledgments

I thank Bill Haseler, Paul McFadyen and Alan Tomley, of the Alan Fletcher Research Station, Queensland Department of Lands, Sherwood, Australia, for their generous support and cooperation and for shipments of *M. mellyi.* I thank Don Foster, Olin E. Teague Veterans' Center, Temple, Texas, for special assistance with the attractant studies. I also thank Lisa Bruggman, Ray Ullrich, and Tom Robbins for their assistance in rearing the borers and conducting some of the experiments. I especially thank C. J. DeLoach, USDA Argricultural Re-

search Service, Temple, Texas, for his many helpful suggestions and continued encouragement.

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